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A PARADIGM FOR EXPERIMENTAL MODIFICATION OF THE EFFECTS OF TEST ANXIETY ON COGNITIVE PROCESSES.

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DESCRIPTORS- *ANXIETY, *COGNITIVE PROCESSES, EDUCATIONAL INNOVATION, *PROBLEM SOLVING, CONCEPTUAL SCHEMES, *TESTING,

WHILE IT IS WIDELY RECOGNIZED THAT TEST ANXIETY INTERFERES WITH COGNITIVE PROCESSES, THE RESEARCH FROM WHICH THIS CONCLUSION IS DRAWN TYPICALLY HAS NOT SHOWN WHICH COGNITIVE PROCESSES ARE INTERFERED WITH OR WHAT PRACTICAL STEPS COULD BE TAKEN TO PREVENT SUCH INTERFERENCE. THE REASONS FOR THIS LACK OF USEFUL KNOWLEDGE ARE DISCUSSED. IT IS SHOWN THAT EXISTING CONCEPTS OF ANXIETY ARE NOT SUFFICIENTLY SPECIFIC AND SYSTEMATIZED TO PROVIDE AN ADEQUATE FRAMEWORK FOR APPLIED RESEARCH, AND THAT THE CURRENT GOALS OF RESEARCH ON ANXIETY ARE OVERSIMPLIFIED AND TOO GENERAL. A RESEARCH PARADIGM IS PRESENTED FOR STUDYING THE PROCESSES BY WHICH ANXIETY INTERRUPTS INTELLECTIVE ACTIVITY AND FOR EXAMINING WAYS IN WHICH ENVIRONMENTS MAY BE RECONSTRUCTED SO THAT DISRUPTION DOES NOT OCCUR. THIS PARADIGM CAN PROVIDE INFORMATION ON WAYS IN WHICH LEARNING ENVIORNMENTS CAN BE MODIFIED TO TAKE ADVANTAGE OF THE FACILITATING EFFECTS OF ANXIETY AND TO ELIMINATE ITS DISRUPTIVE EFFECTS. FURTHER, SUCH A PARADIGM PROVIDES A BASIS FOR THE CONSTRUCTION OF RELATIVELY PRECISE MINIATURE THEORIES OF ANXIETY IN RELATION TO COGNITIVE PROCESSES. THIS DOCUMENT WAS SUBMITTED FOR PUBLICATION TO THE AMERICAN EDUCATION RESEARCH JOURNAL. (AUTHOR)

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Abstract

While it is widely recognized that test anxiety interferes with cognitive processes, the research from which this conclusion is drawn typically has not shown which cognitive processes are interfered with or what practical steps could be taken to prevent such interference. The reasons for this lack of useful knowledge are discussed. It is shown that existing concepts of anxiety are not sufficiently specific and systematized to provide an adequate framework for applied research, and that the current goals of research on anxiety are oversimplified and too general. A research paradigm is presented for studying the processes by which anxiety interrupts intellective activity and for examining ways in which environments may be reconstructed so that disruption does not occur. This paradigm can provide information on ways in which learning environments can be modified to take advantage of the facilitating effects of anxiety and to eliminate its disruptive effects. Further, such a paradigm provides a basis for the construction of relatively precise miniature theories of anxiety in relation to cognitive processes.

A PARADIGM FOR EXPERIMENTAL MODIFICATION OF THE EFFECTS OF TEST ANXIETY ON COGNITIVE PROCESSES

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Test anxiety refers to a state of uneasiness, discomfort, fear, or nervousness which an individual may experience when he perceives that his performance is going to be evaluated. Manifestations of test anxiety depend on its extent, the situation in which it occurs, and the individual's characteristic mode of response. Accordingly, anxiety may be manifested in a number of ways varying from admission of nervousness to denial of warranted fear, from avoidance or impulsive blundering through test situations to overly meticulous caution. Test anxiety usually results in poorer performance in complex learning and problem solving situations (Spence & Spence, 1966). The major causes of performance decrement are believed to be failure to attend to relevant parts of the task, intrusion of irrelevant thoughts which interfere with synthesis of necessary data, and escape or withdrawl from the task in order to avoid anxiety (Sarason, Davidson, Lighthall, Waite, & Ruebush, 1960).

The interference of anxiety with certain cognitive processes has long been recognized (Freud, 1925; Taylor & Spence, 1952; Farber & Spence, 1953; Spielberger, 1966). Recent studies have shown that test anxiety has a cumulative adverse effect on IQ measures and school performance throughout the elementary school years (Sarason, et al., 1960; Hill & Sarason, 1966), and is a major cause of failure in college (Spielberger, 1962). Despite increasing concern about the effects of anxiety on intellectual development and performance, however, no concerted research program has been undertaken to discover and develop

school learning environments which minimize its undesirable effects, or eliminate the anxiety itself.

The paucity of such research is understandable in view of the lack of a clear definition of anxiety. First, the constitutive definition of the construct, anxiety, is not clear, with the result that ten theoretical papers on the subject may deal with ten different phenomena. Second, stimuli of anxiety are not clearly understood; carefully conceived laboratory conditions may fail to produce the kind of anxiety which the investigator set out to study and conversely anxiety may be unwittingly engendered by experimental procedures designed to reduce it. Third, the effects of anxiety on behavior are not well understood. It is difficult to predict whether it will cause perseverance or avoidance, increased retention or associative interference, impulsive low latency responding or cautious high latency responding. Fourth, since no extant measure of anxiety is valid, reliable, and highly sensitive, one cannot measure how much an experimental intervention has reduced anxiousness.

Since research on anxiety reduction requires conceptual and methodological tools which we do not possess (i.e., a definition of it, a theoretical rationale for predicting specific treatment effects, and a means of measuring change in anxiety), evidently another research approach to the problem of test anxiety must be sought. A major purpose of this paper is to suggest such an approach.

First, it will be pointed out that while there are many conceptions of the causes and effects of anxiety, none permit specific prediction of the effects of anxiety on intellectual performance since none give a detailed account of the interaction between task variables, cogni-

tive variables, and anxiety level. We will then examine how the kind of research goals and designs one formulates depends on whether this interaction is considered. Finally, a paradigm for studying modification of the effects of anxiety on cognitive processes is presented. This paradigm circumvents the usual problems of definition and measurement.

Inadequacy of Existing Explanation

Many theories purport to explain how anxiety is initially caused and how its many manifestations are brought about. /The recent book, Anxiety and Behavior (Spielberger, 1966), attests to the profusion of explanations of anxiety: it offers twelve essentially different explanations. None are totally contradictory as each deals with a somewhat different set of variables, and its 17 authors almost never quote one another./ While few explanations of anxiety deal directly with test anxiety, none are irrelevant to this concern. However, whether one considers the entire anxiety literature or only the literature on test anxiety, it remains impossible to derive new predictions of the way in which anxiety affects specific cognitive processes and how such effects may be modified. This inadequacy of our present theoretical grasp of test anxiety prevents formulation of relevant problems for applied research.

As the following example illustrates, current explanations of anxiety do not consider enough of the environmental and organismic variables involved to permit formulation of clear, verifiable predictions of the relation between anxiety and cognitive variables.

According to Spence's drive theory explanation of the relation between performance and anxiety, situations requiring a single overlearned

response are learned rapidly and correctly by anxious persons due to their high drive level; however, situations containing choice points for which persons have no existing set of correct, overlearned responses are poorly handled by high anxious persons because their anxiety (high drive) interferes with selection and evaluation of weaker habits in the response hierarchy (Spence & Spence, 1966). On the basis of this rationale, Waite (1959) originally predicted that low anxious persons would out-perform high anxious persons on Porteus maze tasks, since these require consideration of alternative responses at the various choice points. He later modified his predictions in the light of evidence indicating that high anxious persons' performance is facilitated when they are under very little pressure to respond (as is the case in the Porteus maze task). Results supported Waite's later prediction and were explained by him in terms of high anxious persons' greater tendency to be cautious and hence to acquire and consider more information before acting.

This supplementary explanation is coherent with other currently accepted generalizations about anxiety. For example, according to Mandler's interruption hypothesis (1964), the interruption of an ongoing organized behavioral sequence produces negative affect. Spence and Spence (1966) have shown that anxious persons are especially prone to avoidance learning. It is plausible to infer that anxious persons are especially predisposed to avoid the interruption and unpleasantness caused by entering cul de sacs in Porteus mazes by engaging in cautious, vicarious trial and error behavior at choice points. However, while extant knowledge about anxiety is coherent and wide ranging enough to

support Waite's cautiousness explanation, it is too imprecise to permit correct generalization. Why aren't high anxious persons, by virtue of their greater caution, more careful and frequently correct problem solvers whenever there is little pressure to respond? For example, why do they seek less information before making decisions (Lanzetta, 1963); why are their word-association performances more often characterized by errors of comission consisting of emitting first available, incorrect responses (Castaneda, et al., 1956; Stevenson & Odom, 1965)? In what respects do Porteus maze tasks differ from decision making and word association tasks? What cognitive processes do each require and how are these processes affected by anxiety? Explanations such as the foregoing are inadequate for predictive purposes because they fail to specify the range of task and cognitive variables within which they apply.

The Aims of Research Concerning Test Anxiety

There are many statements in the literature about anxiety and ways it might be dealt with which ignore the fact that the effect of anxiety on mental ability may be desirable or undesirable depending on which cognitive processes are required by the given task and how these processes are affected by anxiety. These statements seem to be based on simple ideas such as the following two:

(1) Anxiety is manifested in one or a few relatively coherent syndromes, and the modification of anxiety would involve elimination of these "additional behaviors." This concept and research goal implies that anxiety adds in a simple way to the behaviors manifested in a given situation. It fails to consider that anxiety may interact with every

task characteristic and individual aptitude that is involved in any specific performance.

There are data to indicate that persons vary widely in their mode of response to anxiety, and that within each individual, response is idiosyncratic to the eliciting stimulus (Endler & Hunt, 1964). Moreover, the behavioral effects of anxiety vary widely in relation to the intelligence of the individual (Spielberger, 1962), task difficulty (Spielberger & Smith, 1966), and other differential and task variables. In many cases, some values of these variables combine with anxiety to facilitate behavior.

(2) Anxiety should be gotten rid of because it is responsible for poor learning. Some of the assumptions implicit in this statement are the following. Anxiety is always debilitating. Anxiety causes poor performance rather than poor performance causing anxiety. Anxiety could, in fact, be gotten ride of if we knew more about it, and this would bring about an all around increase in adaptivity of behavior; that is, the totality of persons' responses to their environment could thus be changed, and such a change would constitute an improvement in all respects.

The first two assumptions are incorrect, as documented by Spence and Spence (1966), and Spielberger (1966). The final assumption is too complex to examine and criticize in detail. However, if anxiety has any adaptive functions, this final assumption must be false.

The prevalence of these kinds of simplified ideas probably stem partly from the correlative or differential approach which stresses traits and their effects. Conversely, experimental and process-oriented approaches, which will be suggested in the present paper, stress the extent to which

behavior in specific situations can be changed and the way in which task performance is jointly determined by the task requirements and the abilities and other differential characteristics which the individual possesses.

To further develop an understanding of the flexibility and explanatory power of the experimental and process-oriented approach as opposed to the trait approach, the following distinction is made. While it is not very meaningful to state that anxiety affects the quality of intellective products, it is meaningful to state that anxiety affects the processes which underlie them. This distinction may at first appear to be picayune. However, we should recall that anxiety, per se, may cause nothing; a lack of it may cause poor performance, and the presence of it may cause good or bad overall performance in one or another aspect of problem solving. Which will be the case depends on what processes are required, and how the individual's kind of anxiety affects (if, in fact, it does affect) the task-relevant cognitive processes.

If this distinction is accepted, it must further be granted that analysis of the effects of anxiety on mental ability must involve construction of a model of the cognitive processes which are required for performance of the given task. Such processes might include memory, ideational fluency, evaluative set, attention, etc. The effects of anxiety and of specific task characteristics on the relevant cognitive processes should then be examined. Approaches taken heretofore have been quite different from this. Rather than specifying which cognitive processes were affected by anxiety, explanations have tended to stress the effects of anxiety's motivational aspects upon some final performance

measure. For example, some research has indicated that anxiety reduces performance in such tasks as word association (Palermo, Castaneda, & McCandless, 1956), and stylus maze learning (Farber & Spence, 1953), presumably because anxiety's drive components interfere with the required cognitive processes. Other results indicating that anxiety facilitates certain behavior have usually been explained in terms of anxious persons' higher drive level (Spence & Farber, 1953), willingness to respond (Covington, 1967), and greater cautiousness (Ruebush, 1960). These explanations concerning motivation are probably correct and relevant to understanding the effects of anxiety on cognitive processes. But they do not permit further deduction. Some reflection on the current state of the psychological literature will convince the reader that knowledge of the individual's level of self-awareness, cautiousness, or drive gives one little power to predict the nature of the specific cognitive processes which are affected by these variables in problem solving situations, or the overall effect on intellective behavior. The explanations which have been offered concerning the relation of these intervening variables to cognitive processes are ambiguous and not readily testable. Not only do they fail to specify what cognitive processes are interfered with by anxiety, the conditions under which the relevant cognitive processes are affected also tend to be imprecise. Hence accurate predictions cannot be made concerning the types of problem situations to which research findings may be generalized. Finally, these explanations typically do not indicate in any specific way how persons could be treated or situations modified in order to reduce anxiety or the undesirable effects of anxiety on performance.

A process-oriented, experimental approach, as briefly described above, would differ from the aims, procedures, and resultant explanations of the trait approach in the following way:

Rather than aiming to reduce anxiety, we would attempt to understand how it affects cognitive processes under specified conditions. The relevant conditions and cognitive processes could then be experimentally altered so as to benefit from the facilitating effects of anxiety and to prevent its debilitating effects from coming into play. The major variables in this design are the task variables and whatever cognitive variables a task analysis indicates are involved. Changes which occur as a result of experimental alteration of the task or of the learner's repertoire of cognitive skills would be measured in terms of change in overall performance and in relevant intervening cognitive processes which are measureable. Whether level of anxiety were altered would be of secondary importance. Unanswered questions concerning the nature of anxiety need not prevent our studying its effects. However, the possible outcome of such an analysis of task and cognitive variables might be a clearer conception of the nature of anxiety as a function of the situation in which the individual is required to act. Two results may be obtained through this approach. First, ways may be developed of creating learning situations which utilize the advantages and avoid the disadvantages of anxiety. Secondly, minature theories of the effects of anxiety on specific cognitive processes may be developed.

Let us turn now to the details of such a paradigm.

A Paradigm for Applied Research on Anxiety

In research which is concerned with the effects of anxiety on cognitive processes and with testing whether certain experimental procedures reduce such effects, the difficulty of measuring change in level of anxiety and of yielding clearly defined results may be circumvented as follows:

(1) The initial level of anxiety may be assessed by whatever means is considered valid, such as self-report scales, clinical judgment, etc. Of those subjects whose anxiety is assessed, high and low anxious groups may be formed. Other variables, such as IQ, which are considered likely to affect performance in the given experiment, may also be assessed, and high and low anxious groups may be matched with respect to them. However, there are serious disadvantages to matched designs involving quantitative responses, especially as the number of matching variables increases (Billewicz, 1965). While it may be desirable to equate experimental and control groups with respect to IQ, very complex matching designs are not recommended.

(2) One or more mediating process variables (e.g., discrimination, short-term memory, ideational fluency, ability to evaluate own progress, etc.) and overall performance measures should be selected which, on theoretical grounds, are believed to be affected by anxiety. Changes in some of these mediating variables as a result of experimental intervention should be measured rather than merely inferred. This can be done by requiring subjects to demonstrate what mediational processes have occurred. For example, they may be required to describe or use the information which they have discriminated, to describe remembered information, to produce

relevant controlled associations, or to evaluate their own performance.

(3) The extent to which these mediating and performance variables are affected by anxiety should then be examined in a task designed to yield dependent measures on each of the processes of interest. The subjects in this study serve as a control group for the experimental condition described in (4) below. The task should be well understood by the investigator, with respect to the cognitive processes which it requires and to the other forces which it brings to bear on subjects, e.g., forms of ego threat, or possibilities of punishment. The task should be developed so that relevant measures of mediating process variables can be obtained without destroying their integrity.

(4) Essentially the same procedure as used in (3) should be employed, with the addition of the experimental intervention(s) designed to reduce certain effects of anxiety. These experimental interventions comprise modifications of those cognitive processes which are believed to be affected by anxiety. Some modifications may be produced by changing the task so that different cognitive processes are required. For example, if it is suspected that anxiety interferes with memory, memory support may be provided in the form of diagrams or some other external form of memory. Or, if ability to generate good solution alternatives is thought to be hindered by anxiety, alternatives could be provided. Or, such modification could be provided by training which alters persons' cognitive capacities. For example, augmentation of memory could be provided by teaching individuals verbal and coding skills, use of mnemonic devices or use of notational systems. Augmentation of one's available repertory of solution alternatives could be brought about by frequently requiring and

rewarding production of alternatives, after the manner proposed by Maltzman (1960).

(5) The extent to which the effects of anxiety vary as a function of the experimental treatment may be assessed by comparing the dependent measures of mediating and performance variables of control (3) condition subjects with those of experimental (4) condition subjects. If experimental modification proves satisfactory, this technique could be generalized and developed into practical means of producing the same effect. Adaptation of these methods to requirements of various learning situations in the form of curriculum innovations and teaching techniques could be the final outcome. Experimentation over months of use would indicate the nature of overall changes in learning behavior, if any, which result from these techniques.

Note that this paradigm requires assessment of the <u>initial</u> level of anxiety only. This assessment may be made with any of several instruments typically used to measure anxiety (e.g., self-report scales, physiological measures, teacher ratings, etc.). Despite various problems connected with their use, these instruments provide a fairly adequate basis for grouping extreme scorers into high and low anxiety groups, and thus provide a basis for discriminating between persons who characteristically experience anxiety in evaluation situations, and persons who do not. However, these instruments are usually too insensitive to adequately measure <u>change</u> in anxiety level. For this reason, and because we do not know what changes in intellective processes necessarily accompany anxiety changes, our primary measures of change involve measures of intellective behavior.

To summarize, such a research design would involve a control condition and one or more experimental conditions. Each condition would contain high and low anxious subjects, matched with respect to any other variables considered likely to affect performance. Dependent variables would include composite performance measures such as learning speed, in addition to mediating process measures, such as the number of correct discriminations of problem characteristics. Mediating process variables could comprise any variables (1) which are deemed essential components of the theoretical model of the intellective processes being studied, and (2) which are believed to be susceptible to influence by anxiety as well as by (3) the proposed experimental treatment.

This type of design increases the amount of information that can be obtained from a single experiment in the following ways: (1) it indicates which process variables and composite measures of performance are affected by anxiety and by the treatment, and whether anxiety x treatment interactions occur. (2) It indicates which processes account for overall performance differences. (3) It provides a crude indication of the adequacy of the theoretical model and operational definitions being utilized; treatment-induced changes which are reflected in a process variable but not in a final performance or vice versa indicate that the model contains inappropriate variables, insufficiently sensitive measures, or is not complex enough to adequately characterize the behavior ostensibly being studied.

The kinds of dependent measures called for by the proposed paradigm are such that the main and interaction effects which occur satisfy the requirements of hypotheses derived from a theoretically adequate model of information processing. These measures in connection with the theoretical model

from which they are derived permit a highly acceptable scientific explanation to be given concerning the way in which the experimental treatment affects the problem-solving performance of anxious persons. Effects of anxiety are usually explained in terms of unmeasured intervening variables, but this procedure entails direct assessment of some of them. The obtained "mediating process" data may be examined with respect to its degree of agreement both with the postulated theoretical model and with other literatures concerning those mediating processes, so as to determine whether the results obtained are consistent with other data and theory.

Although it is not a major aim of this research design to yield information about the effects of experimental conditions on anxiety, per se, it may be of theoretical and practical value to discover how these conditions affect persons' level of consciously perceived feelings of apprehension or tension. Thus, for example, the experimenter's hunches could be checked to determine whether the reduction of some forms of anxiety results either from the initial experiment or over the period during which the modification is incorporated in an individual's learning environment. The relation of perceived apprehension to task performance would be a useful addition to our understanding of the effects of anxiety on behavior under various conditions. Speculations have been advanced that highly intelligent, anxious persons learn to control their anxieties, or to use them constructively. In essence, the desired outcome of the proposed applied research is that ways be discovered through which all anxious children may be taught to handle their anxieties. Self-reports of the nature of perceived feelings of anxiety and changes in these as a result of some experimental intervention wouldcast some light on the nature of

constructively used anxiety.

Hence, there are two ancillary measures which may be developed and used in conjunction with this paradigm. These measures would indicate: (1) what kinds of feelings of apprehension or tension are being experienced in what situations, and with what effects on intellective processes, and (2) if and how the experimental treatment has modified any of the individual's consciously perceived feelings of apprehension or tension.

Elaborating somewhat on the problems and assumptions involved in the use of self-report measures of anxiety, the following five points should be kept in mind:

(1) The instrument being used may not measure the kind of anxiety which affects task performance.

(2) Reduction of anxiety may not be brought about by the intervention; other factors may be operative, for example, the task may have been made congruent with the abilities of anxious persons.

(3) Not only may anxiety not have been reduced by the intervention, but the good effects of the intervention might not have been realized unless anxiety were present (perhaps serving a drive function).

(4) Anxiety may change somewhat in character, or in degree, but the instrument may not be sensitive to these changes. This, coupled with the above reasons, necessitates our considering self-report measures of anxiety as ancillary to the main experiment. While it would be desirable to be able to measure changes in perceived anxiety, it is not warranted to assume either that this is possible or that the significance of such changes can readily be understood.

(5) Persons may change with respect to various attributes of anxiety; and some of these attributes may be measured by a given instrument, while others may not. . .

Bearing in mind these limitations of self-report measures of anxiety, efforts to construct such an instrument should be guided by the following considerations as well. It is important to tailor the instrument as precisely as possible to the task which is being used. It should examine the results of whatever anxiety arousing features the task is thought to possess, be they possibility of punishment, monetary loss, ego threat, fear of personal evaluation, or whatever. The experimenter should not rely solely upon his own intuition in composing such an instrument, but should solicit the suggestions of persons who have participated in the task. To further sensitize the instrument to changes in relative dimensions, it may be designed such that items are responded to in terms of the degree to which they are true, on say a five-point scale.[1]

Comparisons may be made between the scores on this measure of control and experimental subjects, both in the initial experiment, and in the course of long-term application of the modification in school learning situations.

An Example of Research Utilizing the Proposed Paradigm

This paradigm was used in an experiment by Sieber and Kameya (1968) in which the relationship between test anxiety and the effects of memory support on children's problem-solving was investigated. It was hypothesized that ability to remember, compare, and utilize alternative sets of informa-

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[1] This sensitive technique for assessing state anxiety was originated by Professor Charles Spielberger.

To summarize, the following diagram illustrates the proposed paradigm:

Selection of cognitive process variables with which there is theoretical reason to believe that anxiety interferes under certain conditions.

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Construction and description of task involving the selected processes under the specified conditions.

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Precise analysis of task to yield a specific model of the cognitive and motivational process required.

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Construction of dependent measures of task performance and intervening cognitive processes.

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Integration into an experimental design comprising a control condition and one or more experimental conditions.

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Administration of task with experimental modifications consisting of:
(a) Alteration of the task to reduce the demand on those cognitive processes believed to be debilitated by anxiety, and to utilize the facilitating effects of anxiety.
or
(b) Augmentation, through training, of the cognitive processes hypothesized to be adversely affected by anxiety.

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Generalize findings on experimental modifications to teaching and curriculum.

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Examine the long term effects of applications of modifications to learners in school situations, in terms of appropriate main and ancillary dependent measures, by comparison with control group.

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Generalized statements of the nature of tasks which require the specified cognitive processes and motivational attributes, and of the ways in which anxiety is believed to affect these processes. Development of relevant examples of situations characterized by this statement. These examples comprise situations to which this applied research may be generalized.

Identification of subjects' test anxiety level & characteristics on other relevant differential measures, e.g., IQ, defensiveness, age. When warranted, these variables should be counterbalanced for and incorporated into the experimental design so that their effects, over & above those of test anxiety may be explained.

Examination of effects of anxiety and other differential variables on those cognitive processes required by the task.

Administration of control task.

Compare with respect to ancillary measures of self-reported feelings of anxiety.

Compare with respect to main dependent measures.

Generalize findings on experimental modifications to teaching and curriculum.

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tion is impaired by anxiety, and that provision of external memory support would improve the performance of high anxious subjects.

A task was constructed requiring the use of memory to retain and compare alternative solution strategies. Although simple in design, the task was difficult to execute. It consisted of a board containing a row of nine small, evenly spaced holes. Four black marbles were placed over the four holes right of center, and four white marbles were placed over the holes left of center. The puzzle was solved when the marbles of the two respective colors had been moved to the end of the board opposite their starting position. Only two types of moves were permitted in the attempt to transpose the positions of these marbles, forward (i.e., toward the opposite end of the board) to an adjacent empty hole, and forward over one adjacent marble of the opposite color to an empty hole. Only one sequence of 24 moves results in the solution. Thus the task is essentially one of learning to make the correct moves. Each move changes the stimulus configuration so that antecedent configurations cannot be referred to unless they can be recalled from memory. If a given sequence of moves leads to an impasse, the ability to avoid repeating that mistake depends on remembering the marble configuration which existed one move prior to the move at which the impasse was obvious. A trial was concluded either when a subject had successfully finished the task or when he had reached an impasse. Subjects could retract incorrect moves only if they had not taken their fingers from the incorrectly moved marble.

An altered version of this task was developed which provides memory support. This version of the marble puzzle provides the subject with three sets of boards and marbles. If a mistake is made, another attempt

is made on the second board; the subject keeps the previously used board intact before him for reference to help avoid similar mistakes. He continues to rotate boards until the correct solution is found.

It was hypothesized that high anxious children would be less able than low anxious children to remember the various marble board configurations in terms of whether they led to success or failure, and thus to evaluate whether a given move would ultimately lead to an impasse. A second hypothesis was that high anxious children's ability to evaluate moves and avoid errors would approach that of low anxious children if memory support were provided.

Two groups of high and low anxious children were matched with respect to IQ, sex, and defensiveness. They were administered the marble puzzle under conditions of memory support or no memory support. Measures of number of errors committed and number of errors recognized before commission (before taking one's fingers off the incorrectly moved marble) were recorded.

An analysis of variance indicated that anxiety significantly impaired ability to reach the solution ($p < .05$, df 1, 32) and to recognize errors before commission ($p < .01$, df 1, 32). As predicted, an anxiety x memory support interaction ($p < .02$, df 1, 32) indicated that memory support reduced undesired effects of anxiety on task performance, such that anxious children performed as well as (actually insignificantly better than) low anxious children.

These data support the hypothesis that anxiety interferes with short-term memory, making it difficult for anxious persons to engage in vicarious trial and error when this must be done on the basis of remembered

information. However, when memory support is provided, anxious persons appear to take advantage of it and thereby to improve their level of performance. Quite possibly, their high level of performance under the experimental conditions is due, in part, to their cautiousness or motivation to avoid failure, since memory support avails to high anxious persons a body of information upon which they may operate with their characteristic penchant for accuracy or correctness.

These data suggest that high anxious persons would benefit from learning to use a variety of external aids such as diagrams, notational systems, outlining systems for organizing general ideas prior to the development of details, use of symbolic logic to provide a paradigm for sorting and organizing complexly related information, etc. In addition, devices and techniques which aid ability to remember and organize material, such as mnemonic devices and verbal encoding of information, may be especially useful to high anxious persons.

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